*THE FUTURE OF VEGETABLE PATHOLOGY.**

On this occasion, as president of the Ohio Academy, it is incumbent upon me to deliver an address, presumably upon some phase of the body of knowledge we call science. Custom points no less unerringly to some topic along the lines of one's chosen pursuit. Doubtless, without any announcement a botanical heading would be assigned to this occasion. For various reasons it has seemed fitting to present to you some thoughts on 'The Future of Vegetable Pathology.' Certainly this cannot be done without considering the history of the rise and progress, nor without discussing the present status of plant pathology from the standpoint both of the investigator and of the teacher. These matters are likely to lead to estimates concerning the rank of vegetable pathology among the divisions of botanical science. Concerning the speaker personally, it is known to most of you that his pursuits are along the line of the study and investigation of plant disease.

Since it is in the cultural aspects of plant life rather than in the original condition of wild plants that pathology has claimed the largest attention, we naturally look to that phase for much of its history. The advance of our knowledge in this helpful line has certainly been gratifying during the closing decade of the nineteenth century.

Plants, as dynamic factors, exhibit certain general and normal activities discernible under widely different conditions of environment, and recognizable in plants of external dissimilarity; the study of these normal activities leads us to plant physiology. At the same time these plants in their usual activities are impinged upon by certain special and general phases of environment, by varying climatic conditions embracing differences in the amounts of heat, light and humidity, exposure to dryness in air or soil, as well as the encroachments of animal life by the cropping of herbivors or the fretting of insects. In response to continuously acting stimuli of this character the plants become modified or adapted to the conditions surrounding them; the study of this adaption leads to ecology.

Studying still these same plants as living organisms, and either in their general functional activities or in their external and internal adaptations or in both, we find that the course of life of the plant is by no means always normal—instead of simple turgor we may have intumescence or edema (dropsy, as our physicians would say); instead of the free water flow contemplated through the conducting tissues we may find the vessels closed. Not only this, external and internal parasites may attack any and all organs of the plants, intercepting light and heat, absorbing, destroying or diverting the usual nutritive substance, penetrating and transforming essential organic tissues, and even totally preventing the attainment of the reproductive functions; these parasites may lie in wait in the soil, be wafted in the winds or be sown with the seed of the husbandman. Otherwise incapable of striking expression by external signs, the plant may find itself fixed in a soil with inadequate or unsuitable or even injurious substances contained therein; accordingly there is stunted growth, reduced vigor or manifest ill health indicated by fruit or foliage. Abnormalities are seen in such and in other ways; their study just as certainly leads us to vegetable pathology.

Pathology is then at least tentatively ranked coordinately with physiology and ecology among the divisions of botanical science which have to do with plants in their life relations. No one of these divisions just enumerated, more than an-

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other, may be successfully cultivated without some knowledge of the other divisions of botany and of allied sciences.

Historically, vegetable pathology has been studied for a long time; at least one work on 'Maladies des Plantes' has a title page date of the early fifties. Of two German works in the nature of general treatises on this subject, still useful, the first editions were issued in the years 1874 and 1880, respectively: I refer to the handbooks of Sorauer and Frank, both of which have passed through subsequent editions. The lamented Winter's little work, 'Die durch Pilze verursachten Krankheiten der Kultur Gewachse,' belongs to about the same period (1878). These were followed by almost synchronous publication of works by Prilleux, Hallier, Tubeuf, Berlese and Marchal in French, German and Italian, respectively. Tubeuf's book was soon translated into English by Smith, and its appearance in that dress has been followed by the handbook of Massée, and by the recent and most excellent work by H. Marshall Ward under the title 'Disease in Plants.'

There are journals too, including the *Zeitschrift für Pflanzen-krankheiten,* edited by Sorauer, now in its eleventh volume, the Zweite Abtheilung of the *Centralblatt für Bakteriologie und Parasitenkunde,* now in its sixth volume. The Italians have the *Rivista di Patologia Vegetale,* of many years' standing, edited by Berlese, and the Dutch the *Tidschrift over Planten Ziekten* edited by Ritzema-Bos. In England society proceedings and journals have been the chief avenues of publication for work on plant diseases; while in the United States, aside from the *Journal of Mycology* instituted by Dr. Kellerman while in Kansas, now no longer published, the publications of the United States Department of Agriculture and of the various experiment stations in the several states have been the chief agencies by which a large and valuable literature on plant diseases has been issued.

Looking at the subject in this manner, we are led to conclude that plant pathology has possessed a well-arranged and systematic body of facts bearing upon the subject, during a period of at least twenty years, and that this body of knowledge has been accessible for that length of time in the form of published handbooks; and further that it has possessed, and still possesses, a large literature issued in periodical form and covering the multitudinous phases of the subject in question.

Has plant pathology meanwhile assumed the coordinate rank herein indicated along with plant physiology and ecology? I fear we must answer negatively in so far as college professorships and university courses are concerned. Aside from the few universities which offer rather brief undergraduate courses in 'vegetable pathology' or in 'plant diseases,' most, or I might say all, American university and college courses offered by well developed botanical departments, consisting of two or more chairs in botany, are silent on this subject.

If the elements of the subject are taught at all they are presented under either plant physiology or the systematic study of fungi, and it is notable that in America's oldest and largest university this division of botany is not recognized as existing. Professor Ward, to whom reference has already been made, responds in a recent letter that his work in plant diseases is all research work and that he offers no separate course upon the subject.

It is easy to understand that up to a recent time no well formulated call had been made for students equipped in this line, and that therefore no demand existed for courses in plant pathology, but certainly the recent expansion in experiment station work, and in that of the United States De-

partment of Agriculture, no longer leaves this position tenable. The writer has sometimes wondered whether we have in this tardiness to apply botany in vegetable pathology a sort of unwillingness or reluctance to place applied science upon a coordinate basis with pure science. Many are aware how relentless was the opposition of the representatives of the old education to putting engineering or applied science courses upon the same basis as the arts course for graduation. Indeed, if I am not mistaken, certain institutions still discriminate against graduates in engineering. Seeing that all this is history, and noting that applied science in the domain of living things offers great difficulties by reason of the variations in the organisms themselves than the sciences applied in engineering and other technological lines, it ought not to surprise us that this applied botany should make at times slow advances. Such has been the case all along the line of agricultural application. It would not be against some things that have already passed into history were the lingering, or inherent hostility to useful knowledge as a part of the subject matter of collegiate instruction to have had something to do with the tardy recognition given to plant pathology in this, the foremost country of the earth, in the application of the remedial methods its study has brought to our people. A good many of us have heard the sneer often accorded to really fine work in applied botany.

However much weight we may give the foregoing considerations, it must not be denied that vegetable pathology as a well-rounded division of botany has been compelled to pass severe tests, to suffer disadvantages.

The tendency in some quarters to restrict the application of the term vegetable pathology to a study of the cryptogamic parasites upon plants has been a great drawback. Parasitology has been developed to the narrowing and dwarfing of the true science. Doubtless this is the idea which finds expression in the catalogued courses of 'economic mycology.' One well-known and liberal-minded botanist, himself a professor of botany, made the remark to me some two years ago that he would acknowledge that we possessed a science of plant parasitology, but that the science of plant pathology seemed to him to require building up on the non-parasitic side before we could consider it a well-developed division of the science of botany. I may mention here in passing that the development in this country of economic entomology, apart from botany, wherein its application rests if it attain economic rank as to plants, has also divided forces when compared with the course of events in Germany and the remainder of Continental Europe.

Granting that the immediate demands for it and the recognized value of the results of the study of fungus parasites have developed the science unequally or disproportionately in that direction, recent advances have certainly tended in a large measure to correct this tendency. While we do not yet know the exact interrelations out of which harm results from the unlocking of oxidizing enzyms at unpropitious times, as is now believed to be true in yellows of the peach and in the mosaic disease of herbaceous plants, notably of tobacco, progress towards a knowledge of this abnormal 'stoffwechsel' has certainly been rapid and has apparently proceeded along safe lines. That many normal processes in plants remain obscure or unsolved does not discourage the plant physiologist; no more should the obscurity of the abnormal deviations cause the plant pathologist to desist from his triumphant progress.

A prominent plant physiologist has recently asserted that an adequate explana-

tion of so simple and fundamental a process as the ascent of sap in plants yet remains to be proposed; other problems in physiology are stated to be equally unsolved. In a like position the vegetable pathologist finds himself with respect to some of the problems of pathology. Unsolved problems there are, and unsolved problems there will remain so long as men continue yearly to extend the boundaries of our knowledge of plant life.

I feel well assured that the state of our knowledge warrants us in recognizing plant pathology as a well-established division of botanical science entitled to the coordinate rank I have earlier indicated. If this be granted then what reasonable grounds exist to warrant the arrangement of courses and the establishment of chairs of vegetable pathology? I think the basis of our modern education affords us but one answer. The state charges itself with educational matters in order that her citizens may be more useful in perpetuating the state and in contributing to its welfare and prosperity. The state is already demanding the services of those who are capable of assisting agriculture by controlling the diseases of culture plants; with the lapse of years these demands promise to develop in increasing proportions.

The institutions of learning which leave their graduates without all the training for this work that the state of our knowledge affords are missing one of the fairest opportunities for usefulness. The graduate who finds that his notes on economic mycology fail to connect his parasite adequately with the changes in its host, will probably accuse his instructor of leaving him to find out for himself what he should have been taught in some manner, at least, while he had a student's leisure and before the unceasing demands of actual service pressed upon him. Generally speaking, American institutions leave the student in this position, or offer him an excellent opportunity to make his own pathological inferences from physiological instruction. In my judgment, the demand for well-considered instruction and research in plant pathology is already formulated and only awaits avenues of expression to make itself felt. It would seem that the land grant colleges and state universities are situated at a great advantage by their opportunities, in the line of courses in a pathological botany that shall be pedagogically sound and actually immediately helpful. They have this fine opportunity because of their relations to the state at large and to the agricultural community in particular, and by either direct or contributory connection with the experiment stations and the United States Department of Agriculture. Have such courses been made prominent and are these great institutions realizing their full opportunities? And are the time and facilities in the way of helpers allotted in our state university or elsewhere, such as make nothing more to be desired? To both of these questions most would give either a qualified or an unqualified negative answer. So long as this is true much remains to be done for the future of vegetable pathology. It may be added that so far as my own inquiries and those of certain of my friends have extended, we find plenty of disposition to create separate chairs in botany in our universities, and properly so, but there is little manifest disposition to provide for instruction in plant pathology. If we contrast this apparent indisposition—I say *apparent* advisedly, for those on the outside can judge as to what is being considered within only by announcements—if, I repeat, we contrast this apparent indisposition of the institutions training the future physicians of the plant world with that existing in medical colleges wherein there

is a very concrete division of pathological subjects, we are forced to conclude that a great deal remains to be done to provide adequately for the future instruction that I am well assured is to be given in vegetable pathology.

A body of well-organized knowledge on plant diseases presented by teachers charged chiefly or solely with the giving of courses or the conduct of investigations in plant pathology is, I am led to believe, not solely by the course of demand for workers, but as well by the development of our agriculture practice, to be the future of vegetable pathology. In so far as I am aware, the only university whose officials have, as yet, expressed a desire and future purpose to put plant pathology on this foundation for the future is not, as one would expect, endowed by public funds, but by private philanthropy. I am hopeful that this will not long remain the case.

In choosing this subject and in the manner of presenting it, I have been guided, as herein set forth inadequately, by a desire to make plain the disproportion between the demands, in the line of applied botany, made upon many of the most competent graduates in botany and in the preparation they have been given for this work. It is recognized that at no other period of the world's history have the universities of the time been subjected to such stress and expense in equipping for the demands of instruction as have fallen upon those of our own day within the last two decades, more especially within the last one. Under these circumstances, with the achievements of applied physical and chemical science in the minds and on the lips of the inhabitants of both town and country, it is not surprising that the equally important economic achievements in botanical science, and especially in pathology, should have been passed without much consideration by a great number whose interests and training lead them to look elsewhere. What has been stated has been offered in the spirit of friendly suggestion and with no desire to misstate or misapply the facts as they now exist. Should this appear to have been done, it will be my greatest pleasure to make corrections.

It is quite generally recognized at the present day that some of the brilliant hopes of the chemist respecting improvement in plant growth have failed of realization, and that after all the sciences which deal with living things have their problems worthy the most competent and best equipped of our scientists. The chemist will now admit that mere chemical analysis of the plant substances gives no adequate knowledge whereby we may solve the vexing problems of plant nutrition, valuable and helpful as the analysis has been. We as botanists, are justified in the faith that our beloved science is at last to come into possession of her full heritage of problems as well as opportunities. Certainly the unrivaled development of American botany in recent years justifies a faith of this sort.

I have thus with hasty preparation, and, as I am well aware, very imperfectly as to result, taken this much of your valuable time in discussing what appears clearly to me to be the larger possibilities of the future of vegetable pathology.

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SCIENTIFIC BOOKS.

Briefwechsel zwischen J. Berzelius und F. Wöhler im Auftrage der königl. Gesellschaft der Wissenschaften zu Göttingen. Mit einem Commentar von J. von Braun; herausgegeben von O. Wallach. Leipzig, Verlag von Wilhelm Engelmann. 1901. Two vols., 8vo. Vol. I., pp. xxii+717, with portrait of Berzelius; Vol. II., pp. 774, with portrait of Wöhler.

Thanks to the great care with which the